GAS PROCESSING

AND

ENVIRONMENTAL PROTECTION IN ALBERTA

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MARCH, 1972.

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APPENDICES

MEMORANDUM

OUR FILE NO.:

FROM: YOUR FILE NO.:

Honourable W. J. Yurko, P. Eng.
Minister of the Environment.

TO: DATE: January 4, 1972.

Mr. Phil Ullman, P. Eng.
Interim Technical Assistant to the Minister.

Re: Sour Gas Plants.

The effects and amounts of sulfur dioxide emissions from natural gas processing plants handling sour gas has been clouded with controversy and confusion. I am therefore requesting that you conduct for me, a factual study and review of all such plants in Alberta.

It is my desire to know the situation as it presently exists with respect to:

a. sulfur being extracted;
b. sulfur being released to the atmosphere;
c. standards and conditions under which each plant is operating;
d. violation of standards where such exist;
e. the regulations under which each plant is operating;
f. and such other data as may be pertinent.

I would also appreciate your recommendations on a future course of action.

I will expect that all government departments and agencies involved provide you with all the information you may need.

W. J. Yurko, P. Eng.

c.c. Dr. E. E. Ballantyne, Deputy Minister.

MEMORANDUM

OUR FILE NO.:

YOUR FILE NO.:

FROM:

P. M. Ullman, P. Eng.
Interim Technical Advisor to the Minister.

TO:

DATE: March 29, 1972.

Honourable W. J. Yurko, P. Eng.
Minister of the Environment.

Re: Sour Gas Plants.

With reference to your memorandum of January 4, 1972, a report on the overall environmental aspects of the sour gas processing industry is attached.

The submission surveys the present programs developed to review the gas processing plant industry; indicates the present approved status of the plants with regard to the existing programs; and makes recommendations regarding new areas that need investigation before, and after, a plant is approved.

Information collected brings to light the fact that the present approach has been applied inconsistently and is totally inadequate to guarantee the type of environment Albertans have come to expect.

New programs will assist in correcting some of the deficits, however, it is imperative that a periodic review be conducted in order to keep the detrimental effects of these plants at a minimum.

All the information presented in this Report was obtained in correspondence with the Energy Resources Conservation Board or from the files of the Department of the Environment (formerly the Division of Environmental Health of the Department of Health). The information depicts the situation as it existed in January, 1972.

At your request, a more detailed inventory is to be carried out by the Department of the Environment and the Energy Resources Conservation Board as outlined in the attached letter.

P. M. Ullman, P. Eng.

ENERGY RESOURCES CONSERVATION BOARD

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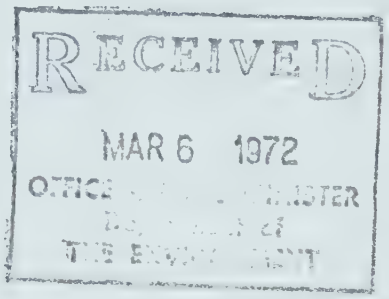
March 3, 1972



Dr. E. E. Ballantyne, D.V.M.
Deputy Minister
Department of the Environment
7th Floor, Milner Building
10040 - 104 Street
Edmonton 14, Alberta

Dear Dr. Ballantyne:

Pollution and Environmental
Control Inventory

Thank you for your letter of February 22, 1972, concerning the pollution and environmental control inventory requested by the Honourable Mr. Yurko. I too have been doing some thinking about this and have discussed it with a number of members of the Board staff. My understanding was that, in the areas of concern to the Board, the inventory would encompass not only gas processing plants but all other operations which could significantly affect the environment. The present thinking of the Board is that the material which we would develop would cover

A. producing wells and batteries
B. drilling operations
C. gas processing plants
D. oil and gas pipelines
E. pipeline terminals, storage and compressor stations
F. power plants
G. transmission lines and associated facilities
H. coal mines
I. coal processing plants

Under each of these headings we would propose to include

1. A statistical indication of the size of the industry, to be used in future inventories to make suitable allowances for growth in the base.

2. The sources and types of pollutants.

3. Measurements of pollutants and their effect on the environment or the community.

4. A review of the current pollution control requirements and standards.

5. A statistical indication of the degree of enforcement, e.g. frequency of inspections, results of the inspections, comments regarding methods of enforcement.

6. A review of the unsolved pollution problems and the steps being taken to solve them.

7. A summary of the general condition of this phase of the industry.

It seemed to us that the objective of the inventory might be to appraise the situation as of about the middle of 1972 and we would hope to have our report completed by about the end of August.

I recall the Honourable Mr. Yurko's reference to the possible availability of summer students to assist in the project. The Board might very well be able to make use of a few such students should they be sufficiently mature and available in the period May, June and July. We are giving further consideration to this now and I will get in touch with you about it later.

Yours sincerely,

G. W. Govier
Chairman

GWG/sjw

cc: Honourable W. J. Yurko

GAS PROCESSING AND ENVIRONMENTAL PROTECTION IN ALBERTA.

This paper summarizes the current status of pollution control and lists new government policies in respect to the sour gas processing industry in Alberta. It is advisable at this time to make public the existing conditions as found by the present government.

A list of all the gas plants in Alberta, Table I, indicates that 64 of the 145 contain measurable amounts of sulfur in their tail gases and are therefore sulfur polluters. The emission of sulfur compounds to the atmosphere from the sour raw gas plants, as sulfur dioxide, ranges from 0.2 long tons per day to 336 long tons per day. In all, approximately 2700 long tons of sulfur dioxide is approved for emission into Alberta's atmosphere daily from this industry alone. This is a considerable amount, and a strong, effective enforcement program is required to protect the environment.

In order to minimize the environmental consequences of this industry, three control programs are presently being practised. These programs are the calculated ground level sulfur dioxide concentrations; the sulfur recovery efficiencies; and the environmental monitoring program. The calculated ground level sulfur dioxide concentrations are determined by the Pasquill or Sutton diffusion equations using the modified Bosanquet effective stack height determination method. Sulfur recovery efficiencies, thus far, are mainly determined by the economics of recovery. Nevertheless, in the last few years a number of technological developments have made it possible to increase sulfur recovery efficiencies economically. The environmental monitoring program consists of monitoring the air in and around a plant.

Calculated Ground Level Concentrations (GLC)

The provincial standards for GLC were formally set by the Provincial Board of Health in 1970, but have been in use since 1959. Using the design, the half hour average GLC of 0.2 ppm or 0.3 ppm sulfur dioxide should allow an adequate safety margin in the ambient standards, which are also 0.2 ppm and 0.3 ppm, but are averaged over a one-hour period. However, as indicated, theoretical mathematical models are used, assuming among other parameters certain average type weather conditions. It is a fact, that at times adverse weather conditions exist (eg. during strong inversion) which render the formulae useless and therefore could result in potential hazards. These mathematical models by themselves, may not allow an adequate safety margin. Adding a limitation on sulfur dioxide concentration in the stack in combination with GLC, would reduce this potential hazard. This is a requirement of revisions being made to the Clean Air Act.

When the new government came into office, a review of the existing plants in the province (Appendix I, Table 1) brought to light the startling fact that eight plants have been approved -- yet there is no record of their GLC, and that eighteen plants have been designed and approved at concentrations in excess of the maximum design value of 0.300 ppm. Of the eighteen plants, thirteen are designed in excess of the Federal Government's maximum acceptable average of 0.34 ppm. An additional five plants have design values in excess of 0.22 ppm in areas where the standard is 0.2 ppm. This represents twenty-three plants out of fifty-five (42%). All of these calculations are based on the plant operating at its approved conditions. At times, uncontrollable process

problems develop which result in slugs of gas being emitted. It should be added that some of the existing plants noted before, were approved under the less restrictive Sutton assumptions. The Pasquill formulae, however, has been available since 1965.

The Federal Government has recommended a desirable ambient one-hour sulfur dioxide standard of 0.17 ppm. Alberta has examined the need to adopt this value as the Alberta standard to protect our environment. Assuming the same safety factors are continued, the resulting half-hour sulfur dioxide standard of 0.17 ppm would result in forty-two plants having to reduce their GLC's. The twenty-three plants indicated earlier are all included in this number.

Sulfur Recovery Efficiencies or Overall Pollution Recovery.

The emission of sulfur into the atmosphere results in the loss of a nonrenewable resource. It is the objective of this government to recover as much sulfur as is technically economically feasible. Sulfur recovery efficiencies are usually determined by a compromise between some minimum based on maximizing economics, and some maximum based on environmental protection. The Energy Resources Conservation Board has been responsible for setting efficiencies. Presently, approximately 94.5% of the sulfur that is in the raw gas is recovered as sulfur. The government recognized a need to increase the overall sulfur recovery efficiency and on November 9, 1971 the Board issued the following guidelines:

B (Board Guidelines)

Inlet rate LT/day	Efficiency based on acid gas quality		
	Favorable	Average	Unfavorable
1000-4000	98 - 99	98 - 99	97 - 99
400-1000	96 - 98	95 - 98	94 - 97
100- 400	94 - 96	93 - 95	92 - 94
10- 100	93 - 94	92 - 93	90 - 92

The existing plants have until the end of 1974 to meet these values. In the interest of effective environmental protection, this table has been modified as follows:

R (Report Recommendations)

Inlet Rate LTDS	Minimum Efficiency %
1000-4000	99
500-1000	98
300-500	96
100-300	94 - 96 depending on gas qualities
10-100	92 - 94 depending on gas qualities

A review of the sulfur recovery plants, (Appendix I, Table 1) indicates that based on the plant approval efficiencies, forty plants require updating based on this Report's Recommendation, and twenty-four plants by the Board's guidelines (42 plants are involved).

Monitoring Program

An effective monitoring program is essential in developing an overall pollution control strategy. The main responsibility for monitoring rests with the individual polluter, while the regulatory agencies of government confine their activities to periodic checking. The government has recognized that there is need to increase regulatory monitoring and this is reflected in the increased budget of the Department of the Environment.

In the past, the sour gas plants have been required to carry out limited monitoring programs. Actual stack gas analysis, thirty day exposure cylinder networks, and in some cases continuous monitoring

for a set time period, have been periodic requirements. Even this existing program appears to be inadequate. Appendix III indicates the monitoring presently approved and being carried out, as well as the additional network increases that are required to bring the existing networks up to a minimum standard. The networks are based on the presently approved plant sulfur dioxide emission rates and the plants need to increase their monitoring immediately.

A review of the monitoring that has been carried out by the Department of the Environment at plants where no design ground level values have been calculated, or where the approved ground levels are in excess of 0.3 ppm. indicates that fifty percent of these plants have never been monitored. Because of this, their environmental impacts are unknown. The Department will rectify this situation as quickly as possible. Appendix III indicates that 53 plants, 34 sulfur recovery and 19 sour flaring plants require additional monitoring.

Monitoring data at present is required within 30 days of the last monitored day. The time period appears to be too lax. Consideration is being given to reducing the requirements to 15 days. No arrangements have been made for contacting the Department when the values are approaching the Ambient Standards. These companies will be required to contact the Department of the Environment whenever a continuous monitoring station has a reading equal to, or greater than, 75% of the appropriate standard as soon as the value is obtained.

The overall monitoring program is presently too limited in nature to provide enough information on the total environmental impact of the plants and therefore will be expanded to include a more extensive variety of tests.

Other types of monitoring that will be required are:

a) Monthly sulfur dustfall readings (4 to 18 stations depending on the size and location of the sulfur piles).

b) Yearly soil survey (number of samples should be two times the proposed exposure cylinder location).

c) Yearly vegetation sampling (number of samples should be four times the proposed exposure cylinder locations).

d) Corrosion studies (number of samples should be one-half the proposed exposure cylinder locations).

A monitoring program consisting of the proposed expanded networks and incorporating the additional tests will result in the Department being able to more accurately judge the environmental impact of the plants.

Complaints

Complaints received by the Department of the Environment and the Energy Resources Conservation Board indicate that improvements in plant operations are required. In 1970-71 two-hundred-and-twenty-six complaints were reported and investigated in fifty-nine different areas of the province. While this may appear to be a substantial number of complaints, it is only a partial list. Many people have ceased complaining to the authorities because of the lack of past action. The authorities have never attempted to prosecute an offender, even when their field investigation reports substantiate the complaint beyond reasonable doubt. It is this government's intention to change this posture.

An aggressive program will be followed to regain the public's

confidence. As the public and industry becomes aware that the moral suasion period has ended, there is expected to be an initial increase in the number of complaints, followed by a sharp decrease.

General

The existing programs have not led to the desirable results of a healthy, clean environment for all Albertans. This is best illustrated by an example.

The latest monitoring values for sulfur dioxide obtained by the Department of the Environment for the Pincher Creek area, indicates peak values of 0.760 ppm; fifteen minute average values of 0.440 ppm; half-hour values in excess of 0.400 ppm; and one hour values in excess of 0.300 ppm. All of these values were obtained on January 28, 1972.

The calculated and approved GLC for this area is 0.200 ppm sulfur dioxide. To date, no prosecution of the Company involved has taken place, based on the violation of provincial regulations. It is very doubtful, however, that successful prosecution could have been undertaken under the existing legislation. Legislation is being revised to remedy this condition.

To reduce the loss of a non-renewable resource, the emission tonnage per day will be limited. At the present time, plants are each emitting as much as 336 tons of sulfur dioxide per day. The maximum release by any one plant will be reduced substantially.

To minimize the presently uncontrollable meteorological factors, consideration will be given to developing maximum stack gas concentrations of sulfur compounds in an exhaust system. This will permit

control of pollution at the source in accordance with announced government policy. Presently, a concentration of sulfur dioxide in the stack in the range of 5000 ppm to 20,000 ppm exists. This indicates the inconsistencies that have been approved. Also the concentrations bear no relationship to plant capacities.

The overall presence of a large gas processing plant in an agricultural or recreational area is not always pleasing to the public. Therefore, aesthetical standards will be incorporated in the environmental consideration of a plant in the future.

CONCLUSION AND RECOMMENDATIONS

It is apparent that immediate action is required in the area of environmental protection. In order to upgrade the existing program and remove all the inconsistencies that are in the present program, the following recommendations are presented for immediate consideration:

1) That a review is made of, and regulations developed, limiting the daily tonnage emission of sulfur dioxide by September 1, 1972.
2) That a review is made, and regulations developed, limiting the stack gas concentration of sulfur dioxide by September 1, 1972.
3) That GLC are calculated for all plants and those exceeding the standards make the necessary inlet changes to guarantee that the standards are not exceeded immediately. That all the effected plants immediately install and operate a continuous monitoring trailer until further notice.
4) That consideration be given to adopting the Federal Government standard of 0.17 ppm for sulfur dioxide.
5) That this Report's recommended efficiencies be required and the plants where the sulfur dioxide emission to the atmosphere reduction is greater than 25 tons be required to meet these requirements by June of 1974. The remaining plants have until December of 1974.
6) That all existing monitoring networks be expanded as recommended.
7) That the Division of Pollution Control, Department of the Environment, develop standard procedures and methods regarding the additional recommended monitoring programs and the companies informed of these immediately.
8) That all data required to control pollution be submitted within 15 days of the last day in the report period.

9) That requirements are developed to improve the aesthetics of a plant on the surrounding environment.

TABLE I

GAS PROCESSING PLANTS IN ALBERTA

Name	Operator	Location	Raw Gas MMCFD	Sulfur Dioxide Emission LT/D
Acheson	Can. Nat. Gas Liquid	2-53-26-W4M	8	0.8
Alexander	Mid West Ind.	6-16-56-27 W4M	36	sweet
Bantry	Goliad	33-17-12 W4M	4	0.8
Bigoray	Amoco	6-28-51-8 W5M	13	4.6
Bigstone	Amoco	10-61-22 W5M	56	40
Black Butte	Cdn.-Montana	1-18-18 W4M	10	1
Bonnie Glen	Texaco	SW17-47-27 W4M	50	24.8
Boundary Lake	Imperial	14-85-13 W6M	25	sweet
Brazeau River	HBOG	SW12-46-14 W5M	103	13.4
Brazeau River	Tenneco	6-10-44-12 W5M	67	9.0
Burnt Timber	Shell	13-30-7 W5M	57	48.0
Calling Lake	Albersun	33-72-17 W4M	15	sweet
Carbon	CWNG	8-17-29-22 W4M	150	sweet
Caroline	Altana	12-36-34-6 W5M	11	1.6
Caroline	HBOG	3&4, 20-34-4 W5M	55	7.2
Carson Creek	Mobil	4-23-61-12 W5M	87	sweet
Carstairs	Home	6-3-30-2 W5M	350	24
Carstairs	BPOG	7-28-30-2 W5M	5	3.5
Cessford	Chevron	12-24-26-12 W4M	14	sweet
Cessford	Tidal	3-6-24-10 W4M	16	sweet
Cessford	Amerada	4-15-27-15 W4M	17	sweet
Cessford	Canex	2-31-22-11 W4M	23	sweet
Cessford	Francana	17-26-14 W4M	7	sweet
Cessford	HBOG	2-8-24-12 W4M	125	sweet
Chigwell	Imperial	9-7-41-24 W4M	6	sweet
Chigwell	Tess Hydro.	7-14-41-24 W4M	3	sweet
Connorsville	King Res.	16-34-25-15 W4M	5	sweet
Countess	Sun	6-36-20-16 W4M	22	sweet
Countess	CPOG	10-16-18-15 W4M	6	sweet
Crossfield	Petrogas	10-2-26-29 W4M	312	200
Crossfield	King Res.	14-32-28-2 W5M	3	sweet
Crossfield-East	Amoco	NE14-28-1 W5M	179	197
Edson	HBOG	3&4,11-53-18 W5M	363	39
Enchant	Sun	11-35-13-17 W4M	6	sweet
Equity	Mobil	33-31-23 W4M	15	sweet
Ferrier	Sinclair	9-22-39-8-W5M	9	sweet
Ferrier	Seafort	1-20-39-7 W5M	20	sweet
Ferrier	Amerada	2-6-41-7 W5M	100	sweet

TABLE I - Cont'd.

GAS PROCESSING PLANTS IN ALBERTA

Name	Operator	Location	Raw Gas MMCFD	Sulfur Dioxide Emission LT/D
Ghost Pine	Gulf	SE11-31-21 W4M	110	sweet
Gilby	Gulf	6-13-40-3 W5M	30	sweet
Gilby	Chevron	1-24-41-3 W5M	17	sweet
Gilby	Texaco	15-22-40-3 W5M	58	1.3
Gilby	Cdn. Homestead	10-10-41-3 W5M	10	sweet
Gilby	HBOG	26-40-3 W5M	9	sweet
Gilby	HBOG	12-41-4 W5M	4	sweet
Gilby	Pacific	27-40-3 W5M	25	0.6
Gilby	French Pete	10-12-41-3 W5M	9	sweet
Gilby	Atlantic R.	5-5-40-3 W5M	28	0.4
Gold Creek	Atlantic R.	NW26-67-5 W6M	56	15
Golden Spike	Imperial	NW22-51-27 W4M	25	6
Greencourt	Cdn. Fina	26-59-9 W5M	32	10
Harmattan	Cdn. Superior	NE27-31-4 W5M	246	0
Harmattan	Home Oil	2-3-31-4 W5M	5	1
Harmattan	Cdn. Superior	27-31-4 W5M	49	82
Hartell	Sun	10-12-19-2 W5M	12	2
Homeglen Rimbey	Gulf	S5-44-1 W5M	422	62.6
Hussar	CPOG	12-33-22-18 W4M	20	sweet
Hussar	Tenneco	13-36-24-21 W4M	84	sweet
Innisfail	Shell	1-3-35-1 W5M	15	19.2
Joffre	Imperial	NE17-39-26 W4M	8	6
Judy Creek	Gt. Plains	19-64-11 W5M	5	sweet
Judy Creek	Imperial	15-25-64-11 W5M	26	sweet
Judy Creek	Imperial	15-25-64-11 W5M	145	sweet
Jumping Pound	Shell	13-13-25-5 W5M	248	54
Kaybob	Pacific	8-9-64-19 W5M	80	sweet
Kaybob	HBOG	16-62-20 W5M	178	86
Kaybob	HBOG	3&4-12-62-20 W5M	41	0
Kaybob	HBOG	3&4-12-62-20 W5M	170	86
Kaybob	Chevron	15-59-18 W4M	445	214
Leduc	Imperial	2-34-50-26 W4M	33	4
Lone Pine Creek	HBOG	S23-30-28 W4M	67	21.4
Lone Pine Creek	Cdn. Superior	S27-29-28 W4M	30	14
Marten Hills	Amoco	18-76-25 W4M	143	1.7
Marten Hills	Home Oil	14-22-74-24 W4M	25	0
Mikwan	Ceja Corp.	10-8-37-23 W4M	14	sweet
Minnehik-Buck Lake	Cdn. Delhi	10-5-46-6 W5M	108	5.6
Mitsue	Chevron	30-72-4 W5M	22	sweet
Morinville	Cigol	SE26-54-25 W4M	20	sweet

TABLE I - Cont'd.

GAS PROCESSING PLANTS IN ALBERTA

Name	Operator	Location	Raw Gas MMCFD	Sulfur Dioxide Emission LT/D
Nevis	Gulf	NE33-38-22 W4M	116	29
Nevis	Chevron	SE22-39-22 W4M	100	17.8
Okotoks	Texas Gulf	SW27-20-29 W4M	34.8	52.4
Olds	Amerada	6-18-32-1 W5M	100	64
Oyen	HBOG	13-36-28-5 W4M	4	sweet
Paddle River	Cities Service	13-6-57-8 W5M	27	14
Parflesh	CPOG	12-1-25-22 W5M	2	sweet
Pembina	Goliad	NA	83	sweet
Pembina	Goliad	13-24-48-7 W5M	0	sweet
Pembina	Amoco	17-50-7 W5M	20	sweet
Pembina	Texaco	13-22-49-10 W5M	9	sweet
Pembina	Amoco	2-50-6 W5M	13	sweet
Pembina	Ashland	15-48-3 W5M	7	sweet
Pembina	Cities Service	35-48-4 W5M	13	sweet
Pincher Creek	Gulf	S33-4-29 W4M	148	66
Plain	Voyager	36-52-13 W4M	17	sweet
Prevo	Kerr-McGee	11-20-39-1 W5M	5	sweet
Princess	Murphy Oil	33-19-10 W4M	3	sweet
Princess	Chevron	12-12-20-12 W4M	12	0.9
Princess	Cigol	12-16-20-11 W4M	4	sweet
Provost	TGS Hydro	7-34-34-6 W4M	12	sweet
Provost	N Central Oil	2-35-9 W4M	20	sweet
Provost	Dome	2-2-39-11 W4M	20	sweet
Provost	Provo Gas	9-19-36-5 W4M	85	sweet
Provost	Spooner	10-12-36-8 W4M	10	sweet
Provost	Pamoil	5-38-8 W4M	6	sweet
Quirk Creek	Imperial	4-21-4 W4M	90	30
Rainbow	Aquitaine	10-10-109-8 W6M	75	20
Rainbow	Imperial	23-110-7 W6M	6	0.2
Rainbow	Mobil	NA	21	injection
Rainbow	Amoco	25-107-9 W6M	7	0.5
Redwater	Imperial	29-57-21 W4M	22	3.9
Retlaw	Home	12-2-13-19 W4M	7	0
Samson	Cdn. Fina	11-9-44-24 W4M	3	sweet
Savanna Creek	Saratoga	SE11-8-5 W5M	75	60
Sedalia	Canex	9-29-31-5 W4M	5	sweet
Sedgewich	Atlantic Rich.	2-16-42-12 W4M	6	sweet
Silbald	Sun	5-6-28-2 W4M	6	sweet
Simonette	Shell	6-63-25 W5M	15	20

TABLE I - Cont'd.

GAS PROCESSING PLANTS IN ALBERTA

Name	Operator	Location	Raw Gas MMCFD	Sulfur Dioxide Emission LT/D
Strachan	Gulf	35-37-9 W5M	250	88
Strachan	Aquitaine	S2-37-10 W5M	382	336
Sturgeon Lake	HBOG	2-69-22 W5M	28	9.4
Swalwell	Gulf	33-29-24 W4M	4	sweet
Swan Hills	Atlantic Rich.	10-32-67-9 W5M	6	sweet
Sylvan Lake	HBOG	14-32-37-3 W5M	59	4
Sylvan Lake	Chevron	1-21-38-2 W5M	27	sweet
Three Hills	Amoco	13-13-35-26 W4M	10	sweet
Turner Valley	Gulf	14-6-20-2 W5M	88	9.6
Tweedie	Albersun	28-68-13 W4M	20	sweet
Virginia Hills	Shell	17-64-13 W5M	12	15.2
Vulcan	Dome	24-15-22 W4M	39	1.5
Waskahigan	Amoco	18-64-23 W4M	16	sweet
Waterton	Shell	1&2-20-4-30 W4M	473	248
Wayne	CPOG	5-17-27-19 W4M	19	sweet
Wayne	CPOG	1-20-28-21 W4M	22	sweet
Wayne	Tenneco	12-4-28-20 W4M	23	sweet
Whitecourt	Pacific	26-59-11 W5M	50	12
Wildcat Hills	Cdn. Fina	6-16-26-5 W5M	125	30
Willesden Green	Texaco	1-17-42-6 W5M	12	sweet
Willesden Green	Homestead Oils	13-16-40-5 W5M	5	sweet
Wilson Creek	Amerada	1-29-43-4 W5M	15	2.7
Wimborne	Mobil	12-34-26 W4M	70	43.4
Windfall	Amoco	8-17-60-15 W5M	371	235
Wintering Hills	CPOG	1-18-25-17 W4M	14	sweet
Wood River	Canex	16-9-43-23 W4M	5	sweet
Worsley	Shell	7-22-87-7 W6M	57	sweet
Zama	HBOG	NW12-116-6 W6M	13	injection

NA - not available

Appendix I

A Review of Calculated Sulfur Dioxide Ground Level Concentrations for Gas Plants.

The provincial ground level standards for sulfur dioxide in Alberta are 0.2 ppm in urban and arable agricultural areas and 0.3 ppm in all other areas (due allowance for trees). The plants' sulfur dioxide GLC's are calculated by two computer models, Pasquill and Sutton, after the effective stack height has been determined by the Bosanquet method. The models yield short period averages (less than 30 minutes). The ambient air quality standards for sulfur dioxide is 0.3 ppm for one hour. Therefore there is a built-in safety factor in the calculated to ambient standards because of the increase in time period. It is suggested that this safety factor is in the order of three.

A review of the GLC of approved plants in the province indicates that eight plants are approved but the GLC have not been calculated, eleven plants are approved based on Sutton, forty-three plants are approved based on Pasquill, one plant is based on continuous ambient monitoring measurements and one plant is based on meteorological wind speed and directional conditions.

The eight plants that GLC have not been calculated for are:

1. Canadian Natural Gas Liquids - Acheson
2. Canadian Montana - Black Butte
3. Hudson's Bay Oil & Gas Co. Ltd. - Brazeau River
4. Atlantic Richfield - Golden Spike
5. Canadian Fina - Greencourt
6. Imperial Oil Ltd. - Leduc
7. Amoco - Martin Hills
8. Gulf - Strachan

Of the plants that have been approved, there are eighteen which

have been approved in excess of 0.3 ppm and therefore in violation of the standards. The plants in this category are:

1. Amoco - Bigstone
* 2. Amoco - Crossfield
3. Amoco - Rainbow
4. Amoco - Windfall
* 5. Canadian Fina - Wildcat Hills
6. Chevron - Kaybob
* 7. Chevron - Nevis
* 8. Gulf - Homeglen-Rimbey
* 9. Gulf - Pincher Creek
* 10. Gulf - Turner Valley
11. Hudson's Bay Oil & Gas Co. - Caroline
12. Imperial - Quirk Creek
13. Saratoga Pro. - Savanna Creek
14. Shell - Innisfail
15. Shell - Simonette
* 16. Shell - Jumping Pound
17. Texaco - Bonnie Glen
* 18. Texaco Gulf - Okotoks

The asterisks above indicate plants where the standard probably is 0.2 ppm due to the plant's location. In addition to the above mentioned plants, it would appear that an additional five plants are approved at a GLC in excess of 0.22 ppm in an area where the standard should be 0.2 ppm. These plants are:

1. Canada-Cities - Paddle River
2. Canadian Delhi - Buck Lake
3. Canadian Superior - Harmattan
4. Gulf - Nevis
5. Hudson's Bay Oil & Gas - Sylvan Lake

The two largest emitting plants in the province, Aquitaine Strachan (emission 336 LTD) and Shell Waterton (emission 248 LTD) are approved, at the appropriate standards for their area at a set elevation. Above this elevation it has been assumed that the land cannot be unduly effected because of the limited type of vegetation growth. Petrogas at Balzac (the fifth largest emitter at 200 LTD) is controlled by a monitoring network. In this case they are measuring the ambient conditions and the safety

factors indicated earlier are ignored.

The Federal Government has the authority to establish ambient standards based on the health aspect of humans. The sulfur dioxide standards developed by the Federal Government, one hour ambient measured averages, are 0.34 ppm as a maximum acceptable average and 0.17 ppm as a maximum desirable average. It must be the goal in Alberta to meet the maximum desirable standards. If the same safety factors are to be maintained, then the half hour calculated standard for sulfur dioxide should be 0.17 ppm as calculated by the Pasquill Diffusion Equation (more restrictive) in all areas of the province. All new plants should be required to be designed to this level and a time-table of compliancy be published for updating all existing operations. In all, forty-two existing plants are affected by this new standard (this does not include the plants where GLC has not been run). However, as indicated earlier, twenty-three plants need upgrading immediately to meet the existing Alberta standards.

TABLE I

SOUR GAS PLANTS IN ALBERTA

Plant Name	Sulfur Production LTD	Sulfur Dioxide Emission LTD	Sulfur Recovery Efficiencies A Approved	B Calculated	C Proposed B	C Proposed R	Emission Temperature °F	Stack Height Ft.	Sulfur Dioxide In Stack ppm SO_2	Ground Level Concentration ppm SO_2 @ Distance (ft.)
Acheson	NIL	0.8	0	0	0	0	Flare	40	NA	NA
Bantry	NIL	0.8	0	0	0	0	Flare	65	NA	0.13 @ 1653 S
Bigoray	NIL	4.6	0	0	0	0	Flare	150	NA	0.17 @ 3726 S
Bigstone	375	40	95 (3M)	95	94-96	96	1200	250	12000	0.77 @ 3700 P
Black Butte	NIL	1.0	0	0	0	0	Flare	100	NA	NA
Bonnie Glen	NIL	24.8	0	0	90-91	92-94	Flare	150	NA	0.31 @ 7788 P
Brazeau R. HB	37	13.4	90 (3M)	84.5	90-92	92-94	1000	190	11300	NA
Brazeau R. TEN	41	9.0	90 (3M)	90	90-92	92-94	1000	245	9180	0.20 @ 8900 P
Burnt Timber	187	48	90 (3M)	88.6	94-96	94-96	1000	270	14080	0.22 @ 19550 P
Caroline AL	NIL	1.6	0	0	0	0	Flare	75	17330	0.23 @ 1860 S
Caroline HB	20	7.2	85 (3M)	85	90-92	92-94	1000	170	12920	0.33 @ 2640 P
Carstairs-HOME	48	24	80 (3M)	80	90-92	92-94	1000	200	8540	0.20 @ 5280 P
Carstairs BP	NIL	3.5	0	0	0	0	Flare	100	NA	0.20 @ 2640 P
Crossfield-PET	1930	200	95 (3M)	95.1	98-99	99	1100/1100	400/400	NA	1
Crossfield-AM	1710	197	95 (M)	94.6	98-99	99	1200	300	13960	0.60 @ 10560 P
Edson	280	39	93.7 (3M)	93.7	92-94	94-96	1000	250	8600	0.15 @ 11098 S
Gilby TEX	NIL	1.3	0	0	0	0	Flare	57	NA	0.20 @ 5280 P
Gilby PAC	NIL	0.6	0	0	0	0	Flare	65	NA	0.003 @ 4752 P
Gilby AR	NIL	0.4	0	0	0	0	Flare	100	NA	0.026 @ 4200 P
Gold Creek	100	15	95 (3M)	93.8	95-96	96	1000	200	NA	0.19 @ 5036 S
Golden Spike	NIL	6	0	0	0	0	Flare	110	NA	NA
Greencourt	NIL	10	0	0	0	0	Flare	105	NA	NA
Harmattan HOME	NIL	1	0	0	0	0	Flare	100	NA	0.03 @ 4488 P
Harmattan GS	845	82	95 (3M)	95.4	96-98	98	1000	250	8140	0.23 @ 10560 P

TABLE I

SOUR GAS PLANTS IN ALBERTA

Plant Name	Sulfur Production LTD	Sulfur Dioxide Emission LTD	Sulfur Recovery Efficiencies A Approved	B Calculated	C Proposed B	C Proposed R	Emission Temperature °F	Stack Height Ft.	Sulfur Dioxide In Stack ppm SO_2	Ground Level Concentration ppm SO_2 @ Distance (ft.)
Homeglen-Rimbey	325	62.6	94 (3M)	91.3	94-96	96	1120	200	13840	0.56 @ 4740 P
Hartell	12.8	2	93 (3M)	93	93-94	94	1000	300	12210	0.18 @ 7200 P
Innisfail	108	19.2	90 (3M)	92	94-96	94-96	1000	200	16120	0.56 @ 3696 P
Joffre	27	6	90 (3M)	90	90	92-94	1000	200	18180	0.15 @ 11088 P
Jumping Pound	417	54	93.5 (3M)	93.9	95-98	98	1000	225	10080	0.60 @ 5480 P
Kaybob-HBOG	1070	86	96 (3M)	96.1	98-99	99	1000	230	8240	0.20 @ 7100 S
Kaybob-HBOG	1020	86	96 (3M)	96.0	98-99	99				
Kaybob-CHEV	3043	214	96.6 (3M)	96.6	98-99	99	1000	465	NA	0.34 @ 30900 P
Leduc IMP	NIL	4	0	0	0	0	Flare	90	NA	NA
Lone Pine Cr.										
" " HBOG	240	21.4	96 (3M)	95.7	96	96	1000	230	5420	0.21 @ 5280 P
Lone Pine Cr.	133	14	95 (3M)	95	95-96	96	1000	200	10310	0.21 @ 3170 P
Martin Hills AM	NIL	1.7	0	0	0	0	Flare	187	NA	NA
Minnehik-Buck Lk	32	5.6	92 (3M)	92	92	94	1000	110	5770	0.25 @ 2600 P
Nevis GULF	278	29	95 (3M)	95	95-96	96	1100	320	9390	0.23 @ 7920 P
Nevis CHEV	253	17.8	97 (3M)	96.5	94-96	96	1300	155	7220	0.31 @ 5280 P2
or CHEV		12.6					1200		5120	0.24 @ 5280 P
Okotoks	419	52.4	93 (3M)	94.1	96-98	98	1000	250	10920	0.54 @ 5280 P
Olds	605	64	96 (M)	94.9	96-98	98	1000	300	8200	0.21 @ 8050 P

TABLE I

SOUR GAS PLANTS IN ALBERTA

Plant Name	Sulfur Production LTD	Sulfur Dioxide Emission LTD	Sulfur Recovery Efficiencies A Approved	B Calculated	C Proposed B	C Proposed R	Emission Temperature °F	Stack Height Ft.	Sulfur Dioxide In Stack ppm SO_2	Ground Level Concentration ppm SO_2 @ Distance (ft.)
Pincher Ck	293	66	90 (3M)	90	93-95	94-96	1000	350	16610	0.37 @ 7603 P
Princess CHEV	NIL	0.9	0	0	0	0	Flare	40	NA	0.006 @ 8184 P
Quirk Creek	287	30	95 (3M)	95	94-96	96	1000	350	12900	0.46 @ 4710 P
Rainbow AQ	137	20	93 (3M)	93	94-96	96	1100	100	9130	0.29 @ 5948 S
Rainbow IMP	NIL	0.23	0	0	0	0	Flare	35	NA	0.15 @ 533 S
Rainbow AM	NIL	0.5	0	0	0	0	Flare	40	NA	0.32 @ 1050 S
Redwater	22	3.9	92 (3M)	92	92-93	94	1000	150	11330	0.14 @ 2380 P
Savanna Creek	796	60	93(cont)	96	96-98	98	1000	300	11970	1.73 @ 6600 P
Simonette	94	20	90(cont)	90.2	93-94	94-96	1000	200	16160	0.40 @ 5280 P
Strachan GULF	847	88	95 (3M)	95	96-98	98	1100	410	8060	NA
Strachan AQ	4100	336	96 (3M)	96	98-99	99	1100	300	NA	0.3 3
Sturgeon Lake	62	9.4	93 (3M)	93	93-94	94	1000	175	10130	0.16 @ 5333 S
Sylvan Lake	10	4	85 (3M)	83	90-92	92-94	1000	121	10010	0.25 @ 2640 P
Turner Valley	16	9.6	80 (3M)	77	92-93	92-94	1000	200	20600	0.42 @ 4435 P
Virginia Hills	NIL	15.3	0	0	0	0	Flare	240	NA	0.3 @ 3140 P
Vulcan	NIL	1.5	0	0	0	0	Flare	100	NA	0.08 @ 2640 P
Waterton	2970	248	96 (3M)	96	98-99	99	1000	500	NA	0.2 4
Whitecourt	NIL	12	0	0	0	0	Flare	300	NA	0.18 @ 5280 P
Wildcat Hills	174	30	92 (3M)	92	93-95	94-96	1000	250	7150	0.55 @ 5280 P
Wilson Creek	NIL	2.7	0	0	0	0	Flare	100	NA 1	0.19 @ 6336 P
Wimborne	331	43.4	93 (3M)	94	94-96	96	780	300	12450	0.22 @ 9890 S
Windfall	1975	235	95 (3M)	94.2	98-99	99	1200	400	9970	0.68 @ 8976 P

A REVIEW OF EXISTING AND PROPOSED SULFUR RECOVERY EFFICIENCIES

Traditionally, the basis for setting sulfur efficiency rates has been the maximizing of investment return. In general, the plants were designed to recover between 90% and 95% of the inlet sulfur. The remaining sulfur was incinerated to sulfur dioxide and exhausted to the atmosphere through a stack at approximately 1000°F. The regulatory agencies involved in environmental protection have attempted to increase the recovery rates, but a review of the approved efficiencies (Table I, Appendix I) indicates that they have been only successful in raising the recoveries of the large plants to 96%. Of the sulfur that enters all of the sour gas plants, 94.5% is recovered as sulfur and 5.5% is released to the atmosphere mainly as sulfur dioxide.

On November 9, 1971, "Minimum Sulfur Recovery Efficiency Guidelines" were issued by the present regulatory agency. These Guidelines are reproduced as Attachment I. The Guidelines come into effect at the beginning of 1975, with application for exemption required by May 31, 1972.

A review of the existing plants indicates that there are 24 plants that must increase their efficiencies or apply for an exemption. The seven largest plants presently are approved to emit over 1600 tons of sulfur dioxide per day. Increasing the recovery rate of these plants to 97% - the minimum required in the Board Guidelines - would result in a reduction of approximately 530 LTD of sulfur dioxide. Using the value recommended by this report (see next paragraph), a reduction of over 1200 LTD would be realized.

It is understood that considerable effort went into the preparation of the report on which the Board Guidelines were based, however, it is evident that more stringent regulations are required. In order to conserve a non-renewable resource and protect the environment, this Report recommends the adoption of the following as minimum requirements:

Inlet Rate	Minimum Efficiency (%)
1000 - 4000	99
500 - 1000	98
300 - 500	96
100 - 300	94 - 96 depending on gas qualities
10 - 100	92 - 94 depending on gas qualities

To meet this standard, forty plants will be required to upgrade their facilities. Information has been published by at least one sulfur plant design guaranteeing 99.9% sulfur recovery. Therefore, these efficiencies are technically attainable but considerable industry opposition can be expected. In order to achieve the maximum sulfur dioxide reduction in the shortest time period, the largest plants (those producing over 1500 LTD) should be ordered immediately to begin designing their systems.

PROVINCE OF ALBERTA

ENERGY RESOURCES CONSERVATION BOARD

Informational Letter
No. IL 71-29

TO: All Operators

Sulphur Recovery Requirements
Gas Processing Operations

The Board has indicated in Information Letter No. IL 70-33, dated July 24, 1970, in meetings with operators of gas processing plants, and through the issuance of certain recent processing plant approvals, that an increase in sulphur recovery efficiency would be required within two or three years. Indications were also given that the requirements would be more stringent but would be consistent with current trends in technology.

The Board has considered the matter of appropriate sulphur conservation requirements on the bases of current technology and the economics of sulphur recovery and, bearing in mind its responsibilities respecting pollution control and the impact on the environment of the total sulphur dioxide emissions in the Province, has developed certain minimum sulphur recovery efficiency guidelines. The guidelines are set out in Attachment I and are related to plant size and various acid gas qualities. The plant size categories were determined, having regard for relative economics, practicality and operating flexibility.

Effective immediately, the Board requests that the requirements set out in Attachment No. 1 be used as a guide in the planning of new gas processing plants and major expansions to existing plants. Where in the opinion of an applicant for the approval of a new plant or a major extension special circumstances warrant a deviation from the guidelines, the Board will consider an application for approval of a lower recovery and will decide the matter on its individual merits.

With regard to existing processing plants, the Board believes that such plants should be upgraded in accordance with the guidelines wherever practicable and that all plants should meet the standards as soon as possible but not later than December 31, 1974. In order to facilitate the achievement of this goal applications for approval of proposed modifications, in accordance with section 9.020 of the Oil and Gas Conservation Regulations, should be made not later than May 31, 1973, with construction to begin as soon as possible thereafter. The Board appreciates that upgrading may not be justified for certain older plants and is prepared to accept applications for exemption from the prescribed recovery levels, or for lesser adjustments, where exceptional circumstances exist. Applications for such exemptions should be made to the Board not later than May 31, 1972.

ISSUED at the City of Calgary, in the Province of Alberta, this 9th day of November, A. D. 1971.

ENERGY RESOURCES CONSERVATION BOARD

G. W. Govier
Chairman

Minimum Sulphur Recovery Efficiency Guidelines

(Inlet rate LT/day)	Process Requirements	Required Recovery Efficiency for Various Acid Gas Qualities		
		Favourable	Average	Unfavourable
1000 to 4000	Stack clean-up required	98-99	98-99	97-99
400 to 1000	Minimal stack clean-up or equivalent process	96-98	95-98	94-97
100 to 400	Minimum of 3 stage Claus plant or equivalent process	94-96	93-95	92-94
10 to 100	Minimum of 2 stage Claus plant or equivalent process	93-94	92-93	90-92

A REVIEW OF EXISTING MONITORING PROGRAMS

The present monitoring requirements for the majority of the plants consist of exposure cylinders, source sampling, and continuous monitoring. The following is a review of each of these areas.

The recommended monitoring increases for each plant are based on their presently approved sulfur dioxide emission limit and are an attempt to provide an adequate program. In all of the recommendations regarding monitoring, there are plants presently operating programs within the proposed ranges.

1. Exposure Cylinder Networks

The majority of sour gas plants in the province maintain a limited exposure cylinder network for the measurement of total sulfation and hydrogen sulfide (Table 1). However, six plants that process sour gas do not maintain a network. These plants are approved to contribute 12.1 long tons of sulfur dioxide per day and are:

1) Goliad - Bantry
2) Canadian Montana - Black Butte
3) Amoco - Martin Hills
4) Amoco - Rainbow
5) Chevron - Princess
6) Imperial - Rainbow

The results obtained from the existing networks are submitted to the Department of the Environment before the end of the month following that for which the observations were made.

A review of the existing networks indicates that a consistent approach has not been employed. In order to have this consistency, and more important to indicate minimum network requirements for effective

measurement, Table I is recommended. Table II indicates the monitoring programs presently carried out by the plants. Adopting the recommended network as suggested in Table I, we find that 27 sulfur recovery plants and 11 sour gas flaring plants require network additions. The additional requirements for these plants are presented in Table III. Besides the six listed above as having no networks, there are an additional 12 plants that are operating networks less than HALF of what they should be.

1) Amoco - Bigstone
2) Aquitaine - Rainbow
3) Atlantic Richfield - Gold Creek
4) Canada-Cities Service - Paddle River
5) Canadian Superior - Harmattan
6) Gulf - Nevis
7) Imperial - Quirk Creek
8) Saratoga Pro. - Savanna Creek
9) Shell - Burnt Timber
10) Shell - Jumping Pound
11) Shell - Virginia Hills
12) Texas Gulf - Okotoks

The required data is submitted usually in the last week of the stipulated time period. This report recommends that the information be submitted by the 15th day of the month following, and that all networks be changed on or about the last day of a month. In this manner, not only would the Department of the Environment be able to determine the trends in the vicinity of each plant, but the individual plant trends could also be compared and the overall provincial trend indicated.

2. Source Sampling

Source sampling is presently carried out at all plants that use a stack to emit their effluents into the atmosphere (Table II). The main purpose of these tests is to determine the actual tonnage of

sulfur emitted from the plant and the operating efficiencies. Using the obtained data it is also possible to calculate ground level concentration. This report is recommending an additional design program limiting the concentration of sulfur dioxide in the stack (Appendix IV). In actual plant operations, the proven method for obtaining this information is stack sampling. Therefore it is imperative that the plants be required to conduct a sufficient number of tests. A minimum number of source sample tests is recommended in Table I. These samples would be carried out to compliment the continuous monitoring requirements.

Twelve plants require additional surveys to meet these minimums (Table II). These are:

1) Amerada Hess - Olds
2) Amoco - Crossfield East
3) Amoco - Windfall
4) Aquitaine - Strachan
5) Gulf - Pincher Creek
6) Home Oil - Carstairs
7) Hudson's Bay Oil & Gas - Brazeau River
8) Hudson's Bay Oil & Gas - Kaybob
9) Imperial - Quirk Creek
10) Saratoga - Savanna Creek
11) Shell - Burnt Timber
12) Texas Gulf - Okotoks

The results of the sampling program are forwarded to the Energy Resources Conservation Board as soon as they are available. Usually the reports are submitted within a month. This report would recommend the data be submitted within 15 days.

3. Continuous Monitoring

Continuous monitoring for sulfur dioxide and hydrogen sulfide is the newest of the three monitoring approaches developed to date. The information gathered by the instruments indicates the actual ambient

conditions. When a value is recorded in excess of the standards, then this is a fact, this is what is actually happening; therefore this type of program indicates the extent of pollution that is occurring. The results are submitted monthly, similar to the approach developed for exposure cylinders.

Five sulfur recovery plants and nineteen sulfur flaring plants do not carry out any continuous monitoring (Table II). The sulfur plants are:

1. Hudson's Bay Oil & Gas - Brazeau River
2. Hudson's Bay Oil & Gas - Caroline
3. Hudson's Bay Oil & Gas - Sylvan Lake
4. Shell - Burnt Timber
5. Tenneco - Brazeau River

In addition to these five plants, there are ten more that are not carrying out an adequate program and must be upgraded (Table III). These are:

1. Amoco - Bigstone
2. Canada Fina - Wildcat Hills
3. Gulf - Nevis
4. Gulf - Rimbey
5. Hudson's Bay Oil & Gas - Edson
6. Imperial - Quirk Creek
7. Mobil - Wimborne
8. Saratoga - Savanna Creek
9. Shell - Jumping Pound
10. Texas Gulf - Okotoks

The sulfur flaring plants are indicated in Tables II and III.

As mentioned above, the required data is submitted within thirty days. This is not an adequate approach because it can happen that the Department of the Environment is not being notified when a standard is violated until sixty days later. By that time, irreversable damage could have been done and it may not be possible to know which plant was responsible. It is recommended that when the standards are

approached, the Department must immediately be notified. In this way, the area affected can be carefully scrutinized for pollution damage. This will require an adequate communications system between the plants and the Department.

In the Province of Alberta, there are only thirteen out of the sixty-three plants that are conducting a totally adequate monitoring program. The remaining fifty need upgrading in at least one of the three areas discussed above.

In order to provide a more diversified program of monitoring and thereby determine the resulting environmental damage, additional programs are required. Most of the additional programs have been carried out on a limited basis in the past.

1) Sulfur Dustfall

This monitoring program would measure the effect of the sulfur storage piles on the adjoining area. The method is similar to the total dustfall cylinders which the Department has required 'dust' emitting plants to maintain. This approach has recently been attempted in areas where people have complained about the sulfur dust spreading on the land.

With the lack of markets, many of the storage piles have become immense in size and therefore will require a large number of stations. It is recommended that between four and eighteen stations be required within the general vicinity of the plants on an initial basis. The Department of the Environment should review the results obtained and develop standards within the year. Also a maximum sulfur dust standard, similar to the total dustfall

standards, should be established for the entire province.

2) Soil Survey

The effect of sulfur dust and sulfur dioxide on the fertility of the land must be established. Mr. D. R. Walker of the Canada Department of Agriculture has carried out some soil sampling in Alberta. This experimentation should be expanded to include the area of influence in the vicinity of a sulfur dioxide emitting plant.

As an initial program, this report recommends yearly samples be obtained from a number of plots. The number of plots sampled should be two times the proposed exposure cylinder network.

3) Vegetation Sampling

The Department of the Environment, with the assistance of the Department of Lands and Forests, has conducted yearly vegetation sampling in the vicinity of large sulfur plants. It has also required some industries to carry out yearly vegetation sampling in order to determine the plant's effect on vegetation. An industry where this is a requirement is the fertilizer plant if they process phosphate rock.

It is highly inconsistent for the Department to conduct tests on the effect of sulfur plants on vegetation, require certain industries to conduct similar surveys, yet not require the sulfur plant operators to carry out surveys. Information regarding the effects of industry on vegetation is required in all areas of the province from all types of industry. Therefore, this report recommends that the sulfur emitting plants be required to carry out these surveys beginning in 1972. The minimum number of samples reported should be four times the required exposure cylinder networks.

4) Corrosion

In 1967, the Environmental Health Services Division of the Department of Health received a report from Professor P. H. Bouthillier, University of Alberta, on "Corrosion" which had the following conclusion:

> "The tests indicate that the sulfur dioxide level and the hydrogen sulfide level have a definite effect on corrosion".

The Department of the Environment does not measure corrosion at gas plants, nor is the gas processing industry required to perform this duty. Therefore it would appear that Professor Bouthillier's conclusion that there is definite corrosion caused from sour gas plants has been neglected. In order to rectify this 'oversight', it is imperative that industry be required to measure its corrosion effect on the surrounding area. Corrosion plates should be established in the vicinity of all plants emitting sulfur compounds to the atmosphere.

In order to obtain the effect of each plant on its neighbors, test locations in non-polluted areas should be established. In this way, the natural corrosion effects can be compared to the man-made sulfur plant effects. The resultant information could be used to compensate those individuals whose property or location is such that their metal materials are more susceptible to corrosion. Initially, the number of sample locations should be equal to one-half the proposed exposure cylinder networks.

TABLE I

MINIMUM MONITORING REQUIREMENTS

Sulfur Dioxide Emission Rate, LTD	Stack Sampling	Exposure Cylinder	Sulfur Dioxide Emission Rate, LTD	Continuous Monitoring
0.1 - 10	1	2 - 6	0.1 - 5	1 M
10 - 25	2	6 - 10	5 - 25	2 M
25 - 50	3	10 - 20	25 - 25+	12 M
50 - 100	4	25 - 35		
100 - 150	5	30 - 40		
150 - 250	6	30 - 50		
250+	8	35 - 60		

TABLE II

A. MONITORING PRESENTLY CARRIED OUT - SULFUR RECOVERY PLANTS

Plant Name	Sulfur Dioxide Emission LTD	Source Sampling	Exposure Cylinders	Continuous Monitoring	Dept. of the Environment Exposure Cylinders
Bigstone	40	4	6	2M	2
Brazeau River HB	13.4	1	4	0	2
Brazeau River TEN	9.0	1	4	0	0
Burnt Timber	48	2	6	0	0
Caroline HB	7.2	1	4	0	2
Carstairs HOME	24	2	5	12M	4
Crossfield-Balzac	200	6	38	2-12M	6
Crossfield-East	197	4	20	12M	8
Edson	39	4	10	2M	5
Gold Creek	15	2	4	2M	0
Harmattan CS	82	4	10	12M	8
Hartell	2	1	4	2M	0
Homeglen-Rimbey	62.6	4	23	2M	6
Innisfail	19.2	2	13	2M	4
Joffre	6	2	8	12M	0
Jumping Pound	54	4	8	2M	4
Kaybob CHEV	214	6	25	12M	0
Kaybob HBOG	172	4	20	12M	4
Lone Pine Ck. CS	14	2	10	2M	0
Lone Pine Ck. HB	21.4	2	11	2M	4
Minnehik-Buck Lake	5.6	2	4	2M	4
Nevis CHEV	17.8	2	21	2M	10
Nevis GULF	29	3	6	2M	0
Okotoks	52.4	2	7	2M	5
Olds	64	3	17	12M	4
Paddle River*	14	2	4	2M	2
Pincher Creek	66	2	30	12M	6
Quirk Creek	30	2	5	2M	5

TABLE II (cont'd)

A. MONITORING PRESENTLY CARRIED OUT - SULFUR RECOVERY PLANTS

Plant Name	Sulfur Dioxide Emission LTD	Source Sampling	Exposure Cylinders	Continuous Monitoring	Dept. of the Environment Exposure Cylinders
Rainbow AQ	20	2	3	2M	0
Redwater	3.9	1	4	2M	7
Savanna Creek	60	2	8	1M	0
Simonette	20	2	9	2M	0
Strachan GULF	88	4	20	12M	0
Strachan AQ	336	(B)	30	12M	0
Sturgeon Lake	9.4	1	4	2M	2
Sylvan Lake	4	1	10	0	2
Turner Valley	9.6	2	4	2M	1
Waterton	248	6	30	12M	8
Wildcat Hills	30	4	25	2M	4
Wimborne	43.4	4	10	2M	4
Windfall	235	4	20	12M	8

A existing monitoring acceptable

* no sulfur recovery but emission is through a stack

(B) sampling is done at the Board's request

TABLE II (Cont'd)

B. MONITORING PRESENTLY CARRIED OUT - SOUR FLARING PLANTS

Plant Name	Sulfur Dioxide Emission LTD	Exposure Cylinders	Continuous Monitoring	Dept. of Environment Exposure Cylinders
Acheson	0.8	1	0	0
Bantry	0.8	0	0	0
Bigoray	4.6	3	2M	0
Black Butte	1.0	0	0	0
Bonnie Glen	24.8	8	2M	1
Caroline AL	1.6	2	0	0
Carstairs	3.5	2	0	0
Gilby TEX	1.3	2	0	0
Gilby PAC	0.6	1	0	0
Gilby AR	0.4	4	0	0
Golden Spike	6	9	1M	1
Greencourt	10	6	0	0
Harmattan HOME	1	-	0	1
Leduc	4	11	0	0
Martin Hills AM	1.7	0	0	0
Princess CHEV	0.9	0	0	0
Rainbow IMP	0.2	0	0	0
Rainbow AMO	0.5	0	0	0
Virginia Hills	15.3	4	0	0
Vulcan	1.5	4	0	1
Whitecourt	12.0	8	0	0
Wilson Creek	2.7	2	0	1

TABLE III

A. MONITORING REQUIREMENTS - SULFUR RECOVERY PLANTS

Plant Name	Sulfur Dioxide Emission LTD	Additional Source Sampling	Additional Exposure Cylinders	Additional Continuous Monitoring	Comments
Bigstone	40	0	12	10M	
Brazeau River HB	13.4	1	4	2M	
Brazeau River TEN	9.0	0	2	2M	
Burnt Timber	48	2	14	12M	
Caroline HB	7.2	0	2	2M	
Carstairs HOME	24	1	5	0	
Crossfield-Balzac	200	0	0	0	A
Crossfield-East	197	2	15	0	
Edson	39	0	8	10M	
Gold Creek	15	0	5	0	
Harmattan CS	82	0	20	0	
Hartell	2	0	0	0	A
Homeglen-Rimbey	62.6	0	2	10M	
Innisfail	19.2	0	0	0	A
Joffre	6	0	0	0	A
Jumping Pound	54	0	17	10M	
Kaybob CHEV	214	0	10	0	
Kaybob HBOG	172	2	10	0	
Lone Pine Ck. CS	14	0	0	0	A
Lone Pine Ck. HB	21.4	0	0	0	A
Minnehik-Buck Lake	5.6	0	0	0	A
Nevis CHEV	17.8	0	0	0	A
Nevis GULF	29	0	8	10M	
Okotoks	52.4	2	18	10M	
Olds	64	1	8	0	
Paddle River *	14	0	5	0	
Pincher Creek	66	2	0	0	
Quirk Creek	30	1	9	10M	

TABLE III (cont'd)

A. MONITORING REQUIREMENTS - SULFUR RECOVERY PLANTS

Plant Name	Sulfur Dioxide Emission LTD	Additional Source Sampling	Additional Exposure Cylinders	Additional Continuous Monitoring	Comments
Rainbow AQ	20	0	7	0	
Redwater	3.9	0	0	0	A
Savanna Creek	60	2	17	11M	
Simonette	20	0	0	0	A
Strachan AQ	336	8	15	0	
Strachan GULF	88	0	10	0	
Sturgeon Lake	9.4	0	0	0	A
Sylvan Lake	4	0	0	2M	
Turner Valley	9.6	0	2	0	
Waterton	248	0	10	0	
Wildcat Hills	30	0	0	10M	
Wimborne	43.4	0	8	10M	
Windfall	235	2	20	0	
Total: 41					

A existing monitoring acceptable

no sulfur recovery but emission is through a stack

TABLE III (cont'd)

B. MONITORING REQUIREMENTS - SOUR FLARING PLANTS

Plant Name	Sulfur Dioxide Emission LTD	Additional Exposure Cylinders	Additional Continuous Monitoring	Comments
Archeson	0.8	1	1M	
Bantry	0.8	2	1M	
Bigoray	4.6	1	0	A
Black Butte	1.0	2	1M	
Bonnie Glen	24.8	2	2M	
Caroline AL	1.6	0	1M	
Carstairs BP	3.5	0	1M	
Gilby TEX	1.3	0	1M	
Gilby PAC	0.6	1	1M	
Gilby AR	0.4	0	1M	
Golden Spike	6	0	0	A
Greencourt	10	0	2M	
Harmattan HOME	1	-	1M	
Leduc	4	0	1M	
Martin Hills AM	1.7	2	1M	
Princess CHEV	0.9	2	1M	
Rainbow IMP	0.2	2	1M	
Rainbow AMO	0.5	2	1M	
Virginia Hills	15.3	5	2M	
Vulcan	1.5	0	1M	
Whitecourt	12.0	0	2M	
Wilson Creek	2.7	0	1M	

Total - 22

A existing monitoring acceptable

A REVIEW OF COMPLAINTS

Attached is a list of complaints received and investigated by the Energy Resources Conservation Board or the Department of the Environment in the years 1970 and 1971.

The complaints are summarized in four categories: odour, smoke, health, and miscellaneous. The miscellaneous category covers such matters as corrosion, vegetation damage, water problems, noise, and sulfur dust.

Complaints have been received from fifty-nine areas during this time period, with the following five areas leading the field:

1. Turner Valley
2. Joffre
3. Waterton
4. Olds
5. Harmattan-Elkton

A strong enforcement program is required to rectify the problem areas.

1970 & 1971

COMPLAINTS SURVEY

THE DEPARTMENT OF THE ENVIRONMENT & THE ENERGY RESOURCES CONSERVATION BOARD

AREA	ODOUR	SMOKE	HEALTH	MISCELLANEOUS
Acheson	1			
Aldersyde	1			
Big Valley	1			
Black Diamond	1			
Buck Lake	1			
Calgary	2			
Calmar	2			1
Chigwell	2			
Clive	2			1
Cochrane	3	4		1
Cremona	1		1	
Crossfield	4			
Didsbury	7			1
Drayton Valley		2		
Edgerton		1		1
Edson				1
Erskine	4	1		1
Fenn-Big Valley	2			
Ferrier	3			
Gilby		1		
Harmatton-Elkton	8		1	1
Homeglen-Rimbey	3			
Hunter Valley	1			
Hussar	9			

1970 & 1971

COMPLAINTS SURVEY

THE DEPARTMENT OF THE ENVIRONMENT & THE ENERGY RESOURCES CONSERVATION BOARD

AREA	ODOUR	SMOKE	HEALTH	MISCELLANEOUS
Jefferson Lake		1		
Joffre	22			1
Judy Creek	1			
Jumping Pound	5			
Lake McGregor	1			
Lathom	2			
Leduc	2		1	
Little Bow	1			
Little Smoky				1
Lloydminster	1			
Lone Pine Creek	1			
Lookout Butte	1			
Mameo Beach	1			
Medicine River	3	2		
Mikwan	1			
Millarville	1			
Nevis	7			
Olds	8	1	1	
Paddle River	1			
Pincher Creek	8			
Quirk Creek	2			
Redwater	6			
Rocky Mountain House	3			

1970 & 1971

COMPLAINTS SURVEY

THE DEPARTMENT OF THE ENVIRONMENT & THE ENERGY RESOURCES CONSERVATION BOARD

AREA	ODOUR	SMOKE	HEALTH	MISCELLANEOUS
Strachan	2			1
Sundre	1			
Sylvan Lake	2	1		
Turner Valley	32			
Valleyview	1			
Violet Grove		1		
Vulcan	4			
Waterton	13			
Whitecourt	1			
Wildcat Hills	1			
Wintering Hills	1			
Wizard Lake	1			1

GENERAL

I. RECOMMENDATIONS REGARDING DAILY TONNAGE LOSS

Appendices I, II, and III indicate what is presently being done in the way of controlling or protecting the environment. All of the existing programs require upgrading in order to make them more effective. However, these programs by themselves are not in keeping with the latest advancements in pollution control. Therefore three additional control parameters must be incorporated into the overall program. These additional methods will compliment the existing programs and bring the controls up to a minimum standard required for the early seventies. No doubt new and more advanced methods will be forthcoming and a constant review must be undertaken in order to keep the program up to date.

1. Tonnage

Sulfur emitted to the atmosphere results in a loss of a non-renewable resource. In order to limit the loss, it is imperative that a rate of emission regulation based on sulfur input be developed. This is the procedure being generally developed by most agencies for the control of particulate emissions; however, it would blend in with the sulfurrecovery plants quite effectively. This program would compliment the sulfur efficiency rates. The regulation would be in the format as indicated in Table I. (The numbers presented are only included to complete the table and while they are in the range to be considered, they are not being suggested at the present time).

TABLE I

ALLOWABLE RATE OF EMISSION BASED ON PROCESS WEIGHT RATE

Process Weight Rate* tons/hour	Rate of Emission tons/day of sulfur
0.5	1
1	2
2	3
3	3.6
4	4.2
5	5
6	5.5
8	7
10	8
15	9.5
20	11
25	12.5
30	13.5
40	17
50	20
75	24
100	28
150	36

* The input of only sulfur is considered in determining the process weight rate.

GENERAL

II. RECOMMENDATIONS REGARDING MAXIMUM ALLOWABLE CONCENTRATION

Of all the methods presently being utilized and suggested, the control of a contaminant in an effluent stream is by far the most important improvement in pollution control. By limiting the contaminant to a percent of the exhaust system that is environmentally safe, all of the inconsistencies present in the GLC approval can be overcome. This method does not concern itself with the loss of a non-renewable resource, but rather with dilution of a contaminant. If the concentration of sulfur dioxide in the effluent stream is limited to the ambient standard, o.3 ppm. then a safe assumption would be that no environment problems would result from this stream. However, such a value may not be practical from a design consideration.

The existing plants have SO_2 concentrations in the range of 5,000 ppm to 20,000 ppm (Table I, Appendix I). There appears to be no relationship between plant size and stack sulfur dioxide concentration. This information is not available for any of the flaring plants or five of the sulfur producing plants.

The limitation of contanimant concentrations in an effluent stream would remove the inconsistencies present in ground level concentration calculations. A detailed review of the existing legislation (other provinces or states) was not undertaken but should be, and Alberta standards established by June 1, 1972. In the interim, all new plants, regardless of size, should be required to limit the sulfur dioxide concentration to under 1,000 ppm. Information is available that indicates a design company is prepared to guarantee a concentration of less than 250 ppm equivalent sulfur dioxide in an effluent.

GENERAL

III. AESTHETICS

In Alberta, an area of pollution control that to date has received no consideration is the actual physical plant with respect to the surrounding environment. In order to maintain Alberta's position as a recreational and tourist-centred province, regulations in this area are required. An example of the type of requirements needed is portrayed at the Shell Oil Bowden Refinery.

Aesthetic standards would not only be applied to the gas industry but should apply to all industries in the province.